National Institute of Environmental Health Sciences

Present and potential future contributions of sulfate, black and organic carbon aerosols from China to global air quality, premature mortality and radiative forcing

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Year: 2009
Journal: Atmospheric Environment. 43 (17): 2814-2822

Abstract:

Aerosols are harmful to human health and have both direct and indirect effects on climate. China is a major contributor to global emissions of sulfur dioxide (SO2), a sulfate (SO4 2-) precursor, organic carbon (OC), and black carbon (BC) aerosols. Although increasingly examined, the effect of present and potential future levels of these emissions on global premature mortality and climate change has not been well quantified. Through both direct radiative effects and indirect effects on clouds, SO4 2- and OC exert negative radiative forcing (cooling) while BC exerts positive forcing (warming). We analyze the effect of China's emissions of SO2, SO4 2-, OC and BC in 2000 and for three emission scenarios in 2030 on global surface aerosol concentrations, premature mortality, and radiative forcing (RF). Using global models of chemical transport (MOZART-2) and radiative transfer (GFDL RTM), and combining simulation results with gridded population data, mortality rates, and concentration-response relationships from the epidemiological literature, we estimate the contribution of Chinese aerosols to global annual premature mortality and to RF in 2000 and 2030. In 2000, we estimate these aerosols cause approximately 470 000 premature deaths in China and an additional 30 000 deaths globally. In 2030, aggressive emission controls lead to a 50% reduction in premature deaths from the 2000 level to 240 000 in China and 10 000 elsewhere, while under a high emissions scenario premature deaths increase 50% from the 2000 level to 720 000 in China and to 40 000 elsewhere. Because the negative RF from SO4 2- and OC is larger than the positive forcing from BC, Chinese aerosols lead to global net direct RF of -74 mW m-2 in 2000 and between -15 and -97 mW m-2 in 2030 depending on the emissions scenario. Our analysis indicates that increased effort to reduce greenhouse gases is essential to address climate change as China's anticipated reduction of aerosols will result in the loss of net negative radiative forcing.

Source: http://dx.doi.org/10.1016/j.atmosenv.2009.02.017

Resource Description

Climate Scenario :

specification of climate scenario (set of assumptions about future states related to climate)

Special Report on Emissions Scenarios (SRES), Other Climate Scenario

Special Report on Emissions Scenarios (SRES) Scenario: SRES A2

Other Climate Scenario: International Institute for Applied Systems Analysis (IIASA) "Current Legislation" and "Maximum Feasible Reduction" scenarios

Exposure :

weather or climate related pathway by which climate change affects health

Air Pollution

Air Pollution: Other Air Pollution

Air Pollution (other): SO2, sulfate precursor, organic carbon, black carbon

Geographic Feature:

resource focuses on specific type of geography

None or Unspecified

Geographic Location:

resource focuses on specific location

Global or Unspecified, Non-United States

Non-United States: Asia

Asian Region/Country: China

Health Impact:

specification of health effect or disease related to climate change exposure

Morbidity/Mortality

Mitigation/Adaptation:

mitigation or adaptation strategy is a focus of resource

Mitigation

Model/Methodology:

type of model used or methodology development is a focus of resource

Exposure Change Prediction, Outcome Change Prediction

Resource Type:

format or standard characteristic of resource

Research Article

Timescale:

time period studied

Medium-Term (10-50 years)